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REPRESENTATION OF LAND FORMS IN THE PHYSIOGRAPHY LABORATORY

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LABORATORY WORK IN GENERAL.—Teachers of physiography in the colleges and the secondary schools have been confronted by the problem of the organization and development of adequate laboratory work as a part of the regular instruction in the subject. There is no general plan acceptable to all, and no unanimity of opinion as to what is best. Each teacher has been forced to depend more or less on his own ingenuity, and to work out his own salvation. His particular teaching environment must also be a large factor in whatever plan or scheme he adopts. Doubtless out of it all will ultimately come a general scheme acceptable to the great majority; but at present, in spite of the fact that there are now a number of good laboratory manuals, there is great diversity instead of uniformity of usage.

In the Cornell Department of Physical Geography the problem of the laboratory work has been the most perplexing of all that have confronted the teacher, and numerous experiments have been tried, especially in laboratory work with land forms. One result of these experiments has been to demonstrate the value of field work even with the most elementary class, and in the very first lessons; and for years it has been the custom to devote all the periods in the open season, both in spring and fall, to organized field study. Indoors, however, where it becomes necessary to substitute *representations* of land forms for the real thing, there has been great difficulty with elementary classes. Map work and work with models have been found dull and uninteresting; as such work leads to no tangible end that the average beginning student recognizes as worth while and it assumes a constructive imagination that the average student does not possess.

Both regional map work and problem map work have been tried; and in each case both teacher and student have welcomed the coming of spring when the real physical geography could be again studied in the open.

So far as we have been able to analyze the difficulty it lies chiefly in the inability of the average undergraduate beginner to see in the map what is really there. The trained observer, with broad experience and well-developed constructive imagination, reads much in it; the untrained observer, even with skilful guidance, little. He lacks the breadth of view necessary to see the features represented. This has been tested in the class on frequent occasions by questioning the student after his study of a map to find out just what he really knows about it; and the result has often been laughable and always discouraging.

It has seemed, therefore, desirable to introduce some form of work which would meet these problems. Attempts have been made to introduce the use of photographs together with the maps, having them studied in relation to one another. As far as it goes this solves part of the difficulty, but one great objection is the impossibility of obtaining photographs enough of just the right kind. Still, when it can be done, it is a great help and in our laboratory work we are making more and more use of the photograph, in the shape of lantern slides, as the best substitute for the real object. These are introduced in the form of quizzes on the pictures thrown on the screen either before or after the class has worked on the maps.[1]

THE NEED OF A WET LABORATORY.—The main object of this paper, however, is to describe another aid to laboratory work which has been introduced chiefly for the purpose of making the study more real,—that is the artificial reproduction of land forms in the laboratory. It has been found to increase the interest of the student; to lead to the better understanding and appreciation of maps, and to make the meaning of maps and map work more real and instructive; and to supply a better basis for constructive imagination upon which to interpret the problems of the map.

This work was begun experimentally by the senior author five years ago; but systematic work with beginning classes was not undertaken until last year, when both the authors took part in the development of this phase of the laboratory work. Enough has already been done to prove the high value of this kind of work with an elementary class, and to find that there are numerous directions along which development may take place. Already work on erosion and deposition, volcanic action, glacial deposits, and

[1]The Use of Lantern Slides in the Teaching of Physiography, by Ralph S. Tarr; New York State Education Department, Bulletin 356, pp. 14-20, October, 1905 (Secondary Education Bulletin 28).

mountain folding has been successfully undertaken, and plans for other work are under way.[1]

At some later time a fuller statement of methods and results will doubtless be published,—after we have had opportunity to develop the matter further. For the present it is proposed to describe the methods and apparatus for only two of the experiments, with a description of some of the results aimed at and attained. This is done in the hope that others may see in such work the benefits which are so clear to us, and try this aid to physiography laboratory instruction. It is also hoped that some may even wish to plan and work out additional experiments; for if there is in this work the value that we believe it to have, it will require the labor of more than one to plan and develop a series of experiments suitable to the needs of a well-rounded laboratory course.

DESCRIPTION OF THE LABORATORY AND ITS EQUIPMENT.—In view of the fact that the work was of an experimental nature, we have not attempted to fit up a laboratory of large size nor with any great degree of elaboration. A small basement room was selected and a cement floor laid, with a gentle slope toward an outlet to which the surplus water drains freely, a screen over the outlet preventing the entrance of coarse sediment. A system of artificial lighting and a supply of water completed the fixed features of the room. The water pipe was tapped at a large zinc-lined sink and at two other points for the attachment of a hose. This is all very simple and quite inexpensive; and such a laboratory, or a better one, might be easily provided in any ordinary school building.

Several pieces of apparatus have been built, but only one need be described for the purpose of this paper. This is a large, square, wooden box, or tank, 8 feet on the side and 16 inches deep. Our tank is made of thick matched boards and is water-tight; but probably a cheaper tank could be made of ordinary boards with a zinc lining; and one could carry on these experiments with a box either larger or smaller than this one. The tank is made for the purpose of holding a body of standing water whose level may be adjusted to suit the requirements. This may be done by any one of several devices: we have used a series of holes with removable plugs.

A second box (5 feet 6 inches on the side and 14 inches deep) was made with a solidly built platform and removable sides. This need not be water-tight, for it is intended solely for the purpose of holding the sand, clay, and

[1] A paper on the work in this laboratory was read by the senior author before the Association of American Geographers at the annual meeting in the Christmas recess of 1907 at Chicago; and by the junior author before the Ithaca meeting of the New York State Science Teachers Association at about the same time. The latter was published under the title "Use of a Wet Laboratory in Physiography Teaching," Education Department Bulletin Number 431, University of the State of New York, pp. 44-49, September 15, 1908.

other materials to be worked upon. The platform, however, should be firmly built to sustain a load. Through each of the four corners of the platform extends a screw used for raising and lowering the platform and for tilting it. On the platform is molded such a land form as is desired; and the outer tank is filled with water to the required height. In erosional and depositional experiments these processes are induced by a spray from one, two or three nozzles; and the land is raised or lowered, or tilted at will, or the level of the water body is varied according to the need.

The materials used in the erosion and deposition experiments were mainly (*a*) common sand; (*b*) moulder's sand; (*c*) ordinary brick clay, ground fine. We tried gravel also but found it too coarse for removal without greatly increasing the volume of water or greatly increasing the slope of the land area. Even common sand is rather coarse for the needs of this work. After several experiments we added a fourth material, that of the recovered mixture of sand, moulder's sand and clay which was deposited during earlier experiments. The use of plaster of paris was also tested, but it was found difficult to avoid making too hard a layer; indeed, the clay itself served well the purpose of a resistant bed. In several of our experiments we succeeded in securing a moderately hard layer by mixing a small amount of plaster of paris with the dry clay, but we would advise extreme caution lest a too large quantity of the plaster be admixed. Slaked lime, powdered, serves the purpose much better. One of the needs which we have as yet been unable to meet satisfactorily in this matter of materials is that of supplying some color to the various layers so that they can be readily differentiated when exposed by erosion. Cheap ochre and other dry colors have been tried but unless very large quantities are used, it has been found that they lose intensity on wetting.

With these materials we built up a land form sometimes with thin, rapidly alternating layers, sometimes with thick layers, or with alternating thick and thin. In some of the experiments the layers were laid horizontally, in others inclined. Some of our land forms were plains, others hilly land, or even miniature mountains; these conditions varying with the result sought.

For the spray we have used the Mistry Jr. nozzles sold for $1.25 by The Goulds Mfg. Co. of Seneca Falls, N. Y. This spray is a mist caused by an ingenious device, and the nozzle is intended for use in spraying plants. For more rapid work the spray from an adjustable hose nozzle, such as is commonly used with garden hose, was employed. With the finer mist one may carry on an erosion experiment for several successive days, even leav-

ing the spray on all night; but where immediate results are desired it is possible to secure them by means of the ordinary adjustable hose nozzle.

So much for the equipment and material used in the laboratory. It might be worth while to detail further the fitting up of the space we have, but that which has been explained serves the purposes of the two experiments or exercises outlined below, with the description of which we will content ourselves in this paper.

THE TEACHING OF CONTOUR MAPS.—There are certain phases of physical geography teaching which offer difficulties common to all schools. One of these is the proper understanding of hypsometric maps, and in this country more especially of contour maps as furnished by the United States Geological Survey. Moreover, most students not only lack appreciation of the expression of elevation, but also are ignorant as to the philosophy of maps and their making in general, that is of triangulation, traverse and scale.

Now the best way to make this clear to the student is by actually putting him, or the class at work in the field with the plane table, the level and the transit; and have made a map of an actual land surface. But even when these instruments are available this presupposes an undue amount of time given to the work by the instructor, as each individual needs personally to perform all phases of the work in order to get a proper appreciation of the line of procedure. As time is generally the scarcest commodity at the teacher's disposal, and this procedure is therefore practically impossible, the following experiment was devised to meet the need as nearly as possible in the laboratory, and make clear as many phases of it as may be possible under the conditions.

Even the least alert member of a geography class will appreciate that a relief model is a miniature expression of a land surface, actual or hypothetical. He has simply in imagination to enlarge its features to the proper degree if he wishes to realize it in nature. Now the problem is to make him appreciate a diagrammatic expression of the same topography.

With these ideas in mind we modeled on a platform, secured by removing the sides from the inner box described above, a hypothetical land surface with as marked a variation in its topographic features as could be built up without too great difficulty, and yet one that did not possess too great complexity of detail. Thus river valleys, a coastal plain, a volcanic peak and an adjacent high plateau easily came within the scope of these limitations. It may be suggested at this point that if the home region, in whole or in part, is varied enough to admit the reproduction of its broad features in this manner, a distinct advantage could be gained by modeling it

for this experiment, since the familiarity of the pupils with its features would lend an added interest to the work.

In the four corners of the platform on which the model was built up were iron collars, threaded, and into these were screwed the cranks by means of which the platform was supported. The threads on the cranks and in the collars were coarse, some ten or twelve turns to the inch. The ends of the cranks were pivoted in iron sockets, screwed fast to the bottom of the outer tank, so that by turning the cranks simultaneously the whole platform, with its incumbent model, could be rapidly raised and lowered at will.

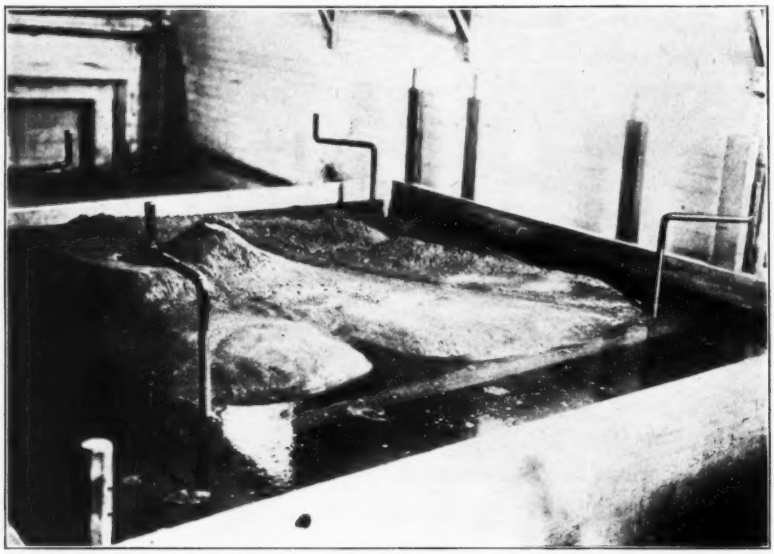


FIG. 1. MAPPING AND CONTOUR EXERCISE
The land form modeled and all adjustments made for the class to begin work.

The materials used in building up the model were sand and clay, with enough plaster of paris admixed to give the forms sufficient firmness to stand up without slumping, when immersed in water for some time. On account of this tendency to slump, it is also well to make the model a day or so before it is to be used. Just before the beginning of the exercise the outer tank is filled with water, the water level being adjusted by means of the plugs on the one side, and the platform lifted, by means of the crank screws, until the water surface coincides with that of the lowest point on

the land surface (Fig. 1) which should be at the level of the platform top, that is, the edge of a coastal plain, or the mouth of a valley. As rendered on the map about to be constructed, the datum plane or sea level will then be expressed by the square outline of the platform top.

These things adjusted, we furnished the students with detail paper, pencils, magnetic compasses, rulers and yardsticks. They were told that the object of this exercise was the making of a contour map of the miniature land surface before them. Immediately there arose the question of what was to be north; thus bringing out the necessity of determining the meridian when a map is to be made. With our compasses this could only be done approximately, owing to the proximity of iron radiator pipes and electrical currents. This deflection of the needle offered an opening for the explanation of the deviation of the needle from true north in most localities, and also an appreciation of the astronomical methods of getting a north and south line.

There came next the question as to what should be the scale of the map, and on this point students in general have only very hazy ideas. Prompted by leading questions, however, they were soon able to fix upon a suitable measure. As our platform is 5 feet 6 inches square, a scale of one inch to one foot was adopted. Then the class was set to work mapping the model by actual measurement from point to point, using the yardsticks on the model and reducing the measurements so obtained to scale; and then by use of the ruler and free-hand sketching to plot them on their maps. The model was large enough to make it possible for a number of the class to take measurements at the same time. This part of the work could be elaborated by introducing some device for reading angles, and so introducing the methods of triangulation, but we did not attempt this.

After the horizontal projection had been plotted in this way, there remained yet the expression of topography by contours. It was pointed out to the students that their map, as made up to this point, was simply a projection of the intersection of the surface features on a horizontal plane. Then, if a set of lines could be superimposed on this map, showing an actual intersection with a plane cutting through at a level a given amount higher than sea level, these would indicate that in going from sea level to this new set of lines, one must, if traversing a land surface such as this relief model portrayed, climb a proportionate elevation; and, vice versa, that he must descend a like amount in going across country from these lines to the sea level. It was also clear that the sea-level line was shown on the map by the square outline of the platform top, and that such lines

were contour lines. It then became necessary to select a contour interval and for our purposes one inch was chosen. This done, the four cranks were turned simultaneously, by four students, a number of revolutions sufficient to depress the platform and its model one inch; the opening in the side of the tank permitting the outflow of the displaced water. There followed the determination of points where the plane, determined by the level of the water, intersected with the surface features (Fig. 2); and then

FIG. 2. MAPPING AND CONTOUR EXERCISE
Locating a contour line.

came the simple task of sketching in the contour; this part of the work being practically a repetition of what had been done before, presented no new difficulties. Meanwhile a blackboard explanation of the methods of leveling in the field was introduced. Successively higher contours were obtained in like manner until the hilltops were submerged. Then by going over the map with colored crayons the culture, hydrographic and hypsometric features were thrown into relief, and the class had produced in a laboratory period a map whose every feature they clearly comprehended as to significance and manner of obtaining. They saw too, and clearly, that not only elevations but also land forms are accurately shown by a contour map.

There are, of course, a number of other uses to which the same model and apparatus could be put; for example in illustrating a drowned seacoast, in demonstrating in connection with the contours the reasons why roads and railroads follow river valleys, etc.

A Lesson in Erosion and Deposition.—In the field, in favorable places, a student may be taken out to study a stream valley; or, failing that, he may study about it in the text, or from photographs, or from maps. In any of these cases he has but the finished form, or possibly only the representation of one. In the same way he may study a delta, or a flood plain, or a meander, or a section of sedimentary strata. In the wet laboratory he may see, in miniature to, be sure, the process, the development, and the result. With this as a basis he can go to the finished product in nature, or to a representation of it, with a better basis for real understanding and interpretation.

One of our wet laboratory experiments has been devised to supply the need just expressed. A land form, a moderately regular though somewhat undulating plain, with a gentle slope toward the sea, is built in the inner box. The plain may be made by almost any combination of layers, though we obtained the best results and the greatest variety of phenomena by using alternating thin layers of moulder's sand and clay with a small amount of plaster of paris mixed with one or two of the clay layers. It is advisable to sift this material on the surface, layer on layer, when building up the land form, as this gives a more uniform thickness, and, moreover, the strata can be deposited in lenticular overlapping patches as is the case in nature. The greatest depth of the material was made in the upper part of the box in order to secure a slope from back to front. In the very back of the box the deposit was a foot or more thick, in the front only an inch or two. The layers varied in thickness, those of moulder's sand being usually about an inch at the thickest part and thinning down toward the front; the clay only an eighth or a quarter of an inch in the thickest part. The top layer is a sheet of moulder's sand.

When the land form is built up, which may be done before the class assembles, the front side of the box is removed and the tank filled with water to the depth of six inches or thereabouts. Then the platform is lowered until the front edge of the land is submerged; and the back side is raised so as to give a sufficient slope for the water to run off freely. One must be sure that the outlet to the tank is large enough to carry off all the water as rapidly as it is sprayed on, and so maintain a uniform level, else no good delta forms will result. When the class assembles they are told to

examine and make notes upon the land form and the surrounding conditions. They are told what lies beneath the surface and what it has been planned to do. They are asked to classify the land form (a young plain); to describe its relationships (a new land form bordering the sea); and to predict the stages in its dissection when exposed to the denudation which is about to be experienced.

The spray is then turned on (Fig. 3), miniature lakes appear, conse-

FIG. 3. EXERCISE IN EROSION AND DEPOSITION

Flashlight photograph taken while erosion was in progress. Note water in the stream valleys, the development of tributaries, formation of a flood-plain, lateral cutting, etc.

quent streams flow in broad courses over many parts of the surface, and there are consequent rapids and falls. The water along the shore line begins to be clouded with sediment. These features are closely observed and recorded, and predictions are called for as to the results. The consequent lakes and waterfalls soon disappear and one or two major streams develop valleys from which tributaries eat backward by headwater erosion; waterfalls appear and recede when the clay layers retard down-cutting; and a delta surface rises to the water level. As the delta grows outward, distributaries appear upon it and there are frequent shiftings in the stream

courses (Fig. 4). With outward growth the lower courses of the major streams are aggraded and meanders develop. All these features are carefully watched and recorded; and the interest of the class in itself has amply justified the time and work required by the teachers; but, even more important than this, the students have been engaged in observation and deduction

FIG. 4. EXERCISE IN EROSION AND DEPOSITION

A later stage of the preceding and after the water level had been lowered. Note the delta outline, distributaries, and the indications of the clay deposit on the bottom. Erosion performed with Mistry nozzle.

and have been securing a basis for fuller appreciation of the related work with maps, photographs and models.

Draining the water from the tank there is seen a perfect delta, with a broad sheet of clay all over the bottom of the tank. These phenomena are studied by observations; their significance is deduced from the observations; and the form and structure of the delta are observed and explained (Fig. 5).

Following this the tank is again filled to the old height, and by directing the hose with a strong current, material is washed into the water and the front of the plain is notched into a wave-cut cliff. Then the spray is turned on once more and the coastal plain dissected at the new base level.

By hurrying the processes this might perhaps all be done in a single afternoon, but by far the best results are gained by starting the experiment on one afternoon, going far enough with it to allow the class to see the changes well under way, then allowing the spray to work with a gentle mist all night, and studying the phenomena at the next period. The work of forming the coastal plain, and the action of waves and currents may also be performed more slowly, giving to it a full laboratory period.

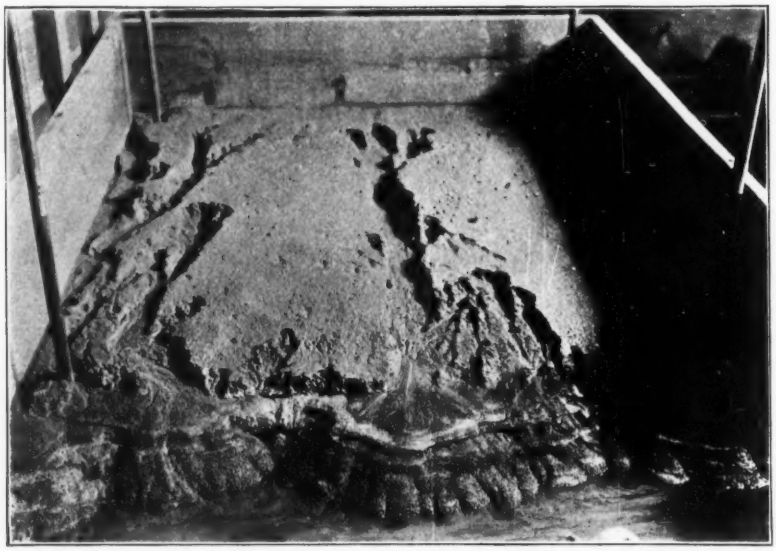


FIG. 5. EXERCISE IN EROSION AND DEPOSITION

Characteristic delta obtained by rapid erosion with hose nozzle spray. Note sheet of clay in front of delta.

Several objects are sought in this work, as follows: (1) arousing and maintaining interest, upon which alone successful instruction is possible; (2) the training of the eye to close observation of details; (3) the exercise of the mind in deductive reasoning from a basis of observed fact; (4) incidentally, the gaining of some information about land forms; (5) the furnishing of a basis for the exercise of constructive imagination in a study of larger features of similar kind, which can be brought before the student only in field work or in some representation of the real phenomenon, as by a map or a model or a photograph.

RELATION TO MAP WORK.—The latter point is sought by subsequent work. In the spring field work the results of the wet laboratory exercises are applied in study of actual land forms; and before this—and in fact during the progress of the wet laboratory work—there is formal laboratory work with maps. Single and grouped sheets of coastal plains and of deltas are studied, in the regular laboratory, in the light of the observational work in the wet laboratory. The study of the stages in the development of plains from youth to old age is undertaken by map and model study; and here, as elsewhere, wherever possible, by the study of typical photographs or slides. The river valley form and its variations; the meander; the floodplain; river piracy; in fact, numerous topics can be taken up and their study correlated with, and made to yield richer results from the basis of simple studies of artificial reproduction of land forms before the eyes of the students.

Our results in these wet laboratory studies have been so satisfactory, from every standpoint, that we have come to look upon this work as no longer of an experimental nature and of doubtful value. It has now a distinct and significant place in our laboratory course. That there are many more possibilities in it than we have discovered we have no doubt. One could even make a whole laboratory course along these lines, though this does not seem desirable; for a study wholly in miniature would lead to unfortunate results from the standpoint of both training and information. There is a distinct and useful field for some of it, however; certainly as much as is outlined here, and probably more. It has been our hope in preparing this brief outline of the work done in the wet laboratory at Cornell University that it may attract the attention of some teachers who will see something of the possibilities in this work and will be led to undertake it in their own laboratories. There will be some hard work for the teacher; but our experience is that the teacher will find himself amply repaid by the results.[1]

The fifth annual meeting of the Association of American Geographers will be held at Baltimore, Md., on January 1 and 2, 1909, in association with the meetings of Convocation Week.

One session will be devoted to a Round Table discussion of Geography for Secondary Schools.

[1] The authors will gladly give further information if desired; and we would willingly permit duplicate copies of our apparatus to be made.

MAN IN WEST NORWAY[1]

By MARK JEFFERSON, Ypsilanti, Mich.

IF we can answer the question where in the world something is, we are talking geography. If we can tell why these people are there, why more numerous than elsewhere, why more happy or more wretched, we may be talking geography or we may be talking history. The conscious and purposeful activities of men, Professor Burr tells us, belong to history, leaving their yieldings to environment and their driftings with the current for geography. I am not attempting to define my science but to illustrate its bearings by a concrete example.

On the old continent of Europe man has densely populated those regions that he has found favorable to his prosperity. He has not always displayed especial intelligence in selecting these spots; he has groped about somewhat, now settling on lands that looked promising to him, now wresting their homes from prosperous-seeming predecessors. He has made mistakes which nature has explained to him by gently withholding her bounty. But after many centuries of trial and contention he has doubtless come to inhabit the most suitable parts of the continent in greatest numbers.

Now in Norway we find men spread out thinner than anywhere else in Europe. For Norway, larger than all Great Britain and Ireland, has barely a twentieth as many inhabitants. Our young state of Michigan with only half the area already has more people. The Norwegians are really so few that the part they have played in history, the contribution they have made to human development and culture is somewhat astonishing in a bare two million of people. The sea was always in the story for they came to their land by sea, by sea they moved about it of old and still to-day, by sea they wandered along every European shore, wresting territory they named Norman from the French king and centuries of spoils from the British islanders, even anticipating in their restless cruising the great exploit of Columbus. To-day, though fewer than any European people, they are fourth in world-rank as owners of merchant ships. In their own continent only England and Germany lead them. Whatever springs of racial, social or historic character may have contributed to so much of achievement, I see here the influence of an inhospitable land to which its dwellers only cling with difficulty.

[1] Reprinted by permission of the author from tenth annual report of Michigan Academy of Science.

Modern geography sees nothing in the Renaissance so fruitful of human culture and progress as the recognition of the ocean as man's highway. That was the gift of Columbus to his fellowmen. That the world was round was known in Plato's day. That a voyage due west from the straits of Gibraltar would bring a ship in time to India had been written down for nearly twenty centuries. But that man could break away from the land and sail straight away to the ends of the earth was a view that began to dawn on men with Columbus' voyage. Beginnings of culture had already come to the races that had learned to move about the Mediterranean, groping always from point to point. Not that man voyaged for culture in those days. It was dominion, power and wealth that was sought, the neighbor's goods taken with the strong hand too often. Similar the quest of Norsemen in France and Britain, of Portuguese and Spanish in America. Once the overpowering fear of the ocean vastness was put aside it was a summer excursion, this voyage from Spain to the West Indies. Down the steady trades by the African coast to the Cape Verde and thence on the same steady winds they sped across the Atlantic, on pleasant sunlit seas. Anything that would float was a ship, any one that would go was a crew, anything was a sail that would hang on the yards and catch the breeze to waft them oversea to the land of gold. To return against the wind was less easy always, but then they would be rich and what matters the discomforts of the voyage? No sailors these; they had no need to be. How different in the north! On storm-swept seas with shifting winds in fog and mist. Sea-faring is a trade here that only the bold-hearted venture on. The weak and the incompetent succumb to the dangers of the sea or flee from them in terror. No school of seamanship could be sterner nor finer than the North Atlantic. This was the school in which the Norsemen learned their trade, here the Dutch and the English sailed the seas. For them the voyage to America was a constant struggle against head winds varied by furious storms. It could not be long before they met the Spaniard on his southern waters and wrested from him the treasures he brought from Mexico or Peru. Presently the Invincible Armada appeared in the English Channel and the English, sailing out in their snug, staunch little ships, met them and drove them down the gale fairly around the British islands to perish—with Spain's pretension to rule the seas. It is significant, it seems to me, that the handful of Norsemen who learned the sea-path in the middle ages should spread their name and deeds so widely and even anticipate Columbus in reaching the new world. Among continentals of this period there

was much wandering of armed men as there had been even in Caesar's day. But these were land wanderings, the horse was the costly means of movement and the knights or horsemen are even to-day in those lands the upper class of society. Nobility was abolished in Norway in 1821, but the essential noble class in the land is its seafarers. Sunday throngs at the boat landings in West Norway show a true peasant class, dull, heavy faced and slow of movement. But the boat officers or even the crew are another type of man, men in whose bearing one sees their possession of the freedom of the earth. At home they had hardly a foothold on a rugged coast. They were not numerous enough to colonize; they founded no empire as did the English whose land is generous enough to support three hundred and sixty people on every square mile. In Norway only three per cent of the land is fit for cultivation, the rest is bare mountain, rock or forest. Eighteen inhabitants to the square mile are crowded there, after a thousand years. In our new land we are already near to thirty, in Michigan, forty-five.

For the geologist and physiographer Norway exemplifies the full development of a type of landscape hinted at by nature in Northern Michigan. It is a land short of soil. The rocky skeleton of the earth is there too much in evidence. If our earth is a ball of rock with a mere dustlike layer of soil on it, here we must bore down a hundred or two hundred feet to get at the rock. Not so in Norway, nor in New England nor in upper Michigan.

In seven hundred miles of Norway I saw no landscape without its rock expanses often more than ninety per cent of all the view. There is also much kinship in the northern rocks. Steam by the north of Scotland south of the Orkney islands, and the land border is a cliff falling sheer to the water or overhanging. Above is a gently undulating land well clothed in green growths. The rocks are sandstones that lie flat in layers. The cliff is the broken edge of the layers. Just such, only smaller, are the cliffs of Put-in-Bay in Lake Erie, at Point aux Barques on the Thumb, or at Petoskey in Little Traverse Bay, and the rocks are just such in lower Michigan, only well seen at such points on the edges of the peninsula, for here too they lie flat in great leaves or sheets. But across the North Sea in Europe or across Lake Huron and North Bay in our lake region we come to another type of scene, so like in both cases that nothing in exernal nature tells us whether we are in the old world or the new. Hummocky tumbled granites in knobs and round waves of rock descend steadily if unevenly from the land beneath the sea. Seaward the knobs are all but

submerged, a fringe of countless islands all of whose contours are round and smooth, but of curves that are of short radius and constantly interrupt each other, intensely rugged, but the ruggedness is one from which all minor roughness and sharpness has been removed by some polishing agency. Naked toward the sea the shoreward face of brown islet and peninsula is scantily clad with plants. These resemblances across the Atlantic rest on a broader similarity in the structure of the continent.

Glance for a moment on our map at the great chain of hollows between the mouths of the Mackenzie and the St. Lawrence, the great Canadian Lakes, as the old world calls them, including Great Bear, Great Slave, Athabasca, Reindeer and Winnipeg as well as the five that we regard as ours. They lie along a four thousand mile curve encircling Hudson Bay. Broadly speaking, the rocks north of this line are all ancient, crumpled, fireworn, Archaean rocks. South of the lakes the same lie deep beneath the flat layers of Paleozoics. It is on these flat lying rocks that most of the American people live. These are the great flat sheets of rock whose edges were said to crop out at Petoskey, at the tip of the Thumb and in the islands of Lake Erie. Among them are the Carboniferous rocks that carry our coal beds.

In Europe a similar line of depressions may be followed through North Sea, Baltic, Gulf of Finland, Lakes Ladoga and Onega and the White Sea, under water most of it here, it stands so low. Here again for a rough description we may say that the rocks to the north are all the ancient gnarled Archaean; to the south appear the flat lying layers on which live the mass of Europe's people, English, French, German and Russian. It was a sample of this that we saw in the Orkneys and northern Scotland.

These contrasts in the land nature are fairly well followed by the tree sorts on the two regions; to the north, needle-bearing conifers, to the south, broad-leaved deciduous trees, though there are numerous excursions of either sort across the boundary, as for instance the pines on the Paleozoics of the southern peninsula of Michigan.

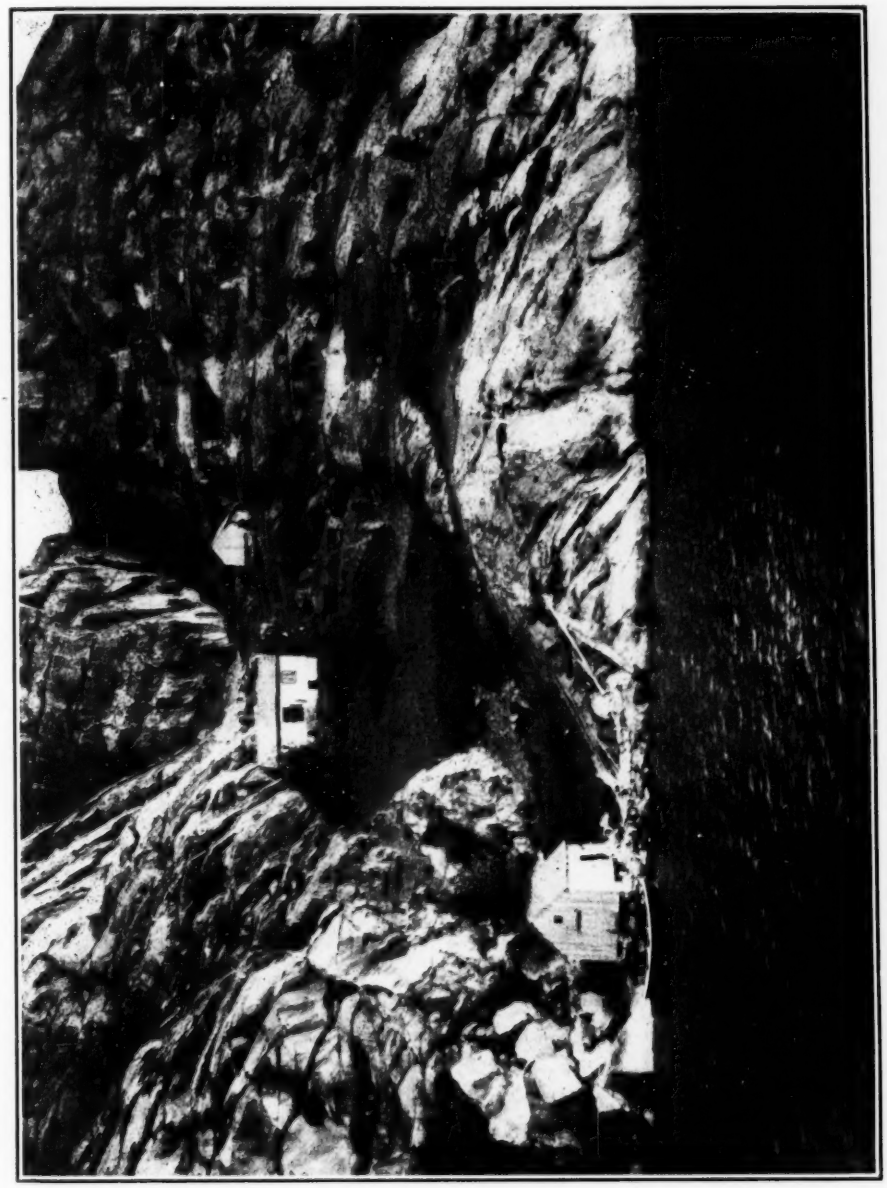
The Baltic Shield of Archaean as has been said displays a type of land form strongly hinted at in the Archaean V south of Hudson Bay. The northern rocks in both cases are fused, molten, crystalline and hard, those of the south dull, earthy, layered and soft. Millions of years of weather had rotted and softened both kinds till their surfaces lay deeply buried in the resultant soils when another and singular thing befell. Its effects were much like the dragging of innumerable brush harrows southward across the Archaean areas and over the border of the southern cover layers.

Details belong to geology. It is the story of the Ice Age. The process swept off the decayed and softened surface portions of the Archaean rock, baring firm, sound, unweathered rock below, which it smoothed and polished at the same time that it left it hummocky and nubbly as its gnarled and crumpled structure demanded. As the sweeping process did not extend far into the southern areas their rocks were rarely stripped, but rather received the sweepings from the north upon their own soils. Thus it happens that our fields in southern Michigan have abundant mineral matter from the country north of our lakes, and Scandinavian rock waste abounds in England, Germany and West Russia. It was in that sweeping process that our field stones, so much firmer and more suitable for building purposes than the rocks found by deep borings under us here—were imported, mostly from Canadian territory.

We know our north country to be a wilderness of rock and forest, therefore a vacation ground for the denser population to the south. It is likely always to remain so, not as any result of the newness of American settlement, but it rests on physiographic grounds as in our European example after long centuries of effort. The physiographic contrast in Europe is stronger than here as we shall now see and where our population falls off from thirty to the mile south of our Lakes to three or four on the north, Germany with two hundred is to be contrasted to Norway with eighteen.

It is precisely in western Norway that the land is rockiest, there where the sea penetrates deeply into the land in the three great fiords, Hardanger, Sogne and Northfiord, extending even sixty miles from the ocean. Offshore is an island swarm identical in origin with the Ten Thousand Islands of Georgian Bay and innumerable channels between. The waters are still, so still it is hard to believe them a portion of the Atlantic Ocean, but any wider space between the islands at once sets our little steamer rolling violently. Nubbled, rounded and hummocky are the rocks all along; on the face toward the land picked out with heather in every crevice but on the ocean side brown and bare. Where shall man live in such a region? We turn a corner to the eastward and enter the harbor of Bergen. It is one of the best footholds west Norway affords. To appreciate it better let us turn our backs on the city as if starting on up the coast to northward and there we see man again losing his foothold on the crumpled rock. The houses seem to cling as long as the slope is gentle enough to let them stick, but it is soil that is scarcer even than houseroom here.

Bergen lies at the mouth of a mile-wide valley that continues for several



miles to the south and west until it comes again to the sea. It has no river but lies flat-bottomed and floored by park-like fields and estates between cliffs a thousand to fifteen hundred feet in height. It needs but a gentle depression to sink the valley floor beneath the sea and produce another sound-like passage among islands. Such it was not many thousand years ago. This soil gathered on the sea bottom, the washings of the land, and almost every foothold man has found in the region has originated in a similar way. The seventy thousand people find its footing scant enough. We may see the city streets climbing high on the valley wall, macadamized, supported by granite walls where the zigzags double on each other and provided with iron hand rails for the foot passenger. The steepness allows the houses to have street entrances at each story. This portion of the city a member of the Norse parliament told me, was not used for residence by the well-to-do classes, not because it was not good for house sites but the land was so cheap there that the poor crowded them out. He did not entertain the idea that there was a geographic reason for this cheapness. But we may go far above the highest of the houses, following the admirable road to a height of a thousand feet on a shoulder of hillside where we may rest at a little restaurant and look out across the whole region,—solitary upland, populous valley, fiord, island and Atlantic. Behind the restaurant a narrower path leads on and we soon have before us a sample of the stuff the land is made of. We are at an elevation of twelve hundred feet on a mile-wide bench. Across the foreground runs the path of crushed stone resting in the heather on a foundation of peat that makes it yield like velvet to every footstep. Farther back rises another seven-hundred-foot cliff of purplish gneiss, almost entirely bare. There is little frostwork here. It is too mild under the breath of the Atlantic.

One sees little rock that has fallen from above. A little farther the truth of this observation is emphasized by the clearness with which a single exception stands out on the valley wall; above, a light gray scar; below, the light gray pile into which the falling rock resolved itself. Every flat surface has its peaty soil and growth of heather. The rocks are everywhere wet and glistening. Down at sea level the rainfall is double that of Michigan, up here probably more still. Plants grow on any pretense of soil. Looking from the summit landward I estimate the bare rock as forty per cent. of the landscape here. In every hollow a lake gathers with water plants and mosses busy filling all about the border. So if we turn and look below to the bench above the restaurant. The heather cover is

closer here. And the bog plants have come nearer to filling their pool. But green as the whole ground is, it has no soil that man can use; only heather and moss can grow upon it. Man is confined to the narrow valley, the great upland surface of the land has no inhabitants. Northward we shall see more desolation, slopes of birch at the waterside, above that heather and over that the desert of bare purple rock and snow.

We turn presently into the Northfiord, passing an occasional group of little houses at the water's edge. For hour after hour one must estimate bare rock the larger part of the landscape. Of what plants are there, only a narrow strip of yellow grass along the fiord edge at the old sea level is of use to man. This fiord is some sixty miles in length to hardly three in width. It is enclosed in strong slopes descending from snow-spotted uplands two or three thousand feet above. In the sunlight it is grand but gloomy more often when roofed over tunnel-like by clouds that hang below the summit of the walls on either hand. At the fiord head is a mile-square patch of land that has inhabitants. It was anciently a delta of mountain streams built into the head of the arm of the sea when the land stood a hundred and fifty feet lower. Looking back over the fiord from this terrace, the scene is one of greater promise for men. Here on the terrace and about the lake above 368 people dwelled in 1904. The valley has been settled a thousand years. The land under such circumstances is very precious. It has no ascertainable price. It is not bought or sold. Each point has its own name and the people all have that name too. Thus the main settlement, Loen, has thirteen peasant proprietors and "always has had." Each of these families is named Loen, the individuals being distinguished by their Christian names commonly with the addition of their father's name, as Marcus Andersen Loen, Rasmus Johansen Loen, Anders Marcussen Loen and so on. Infrequently individuals are found with the name of a neighboring settlement, but the rarity of this denotes fixity of residence through the generations.

Closer to the shore are more signs of men in the landings where are stored the things that come and go in boats. And there is no other approach. There is a road up to the lake, there is a steamer on the lake, and the valley beyond finally heads up at the glacier and cliffs leading to an upland a mile above the sea. All who go up the road come down. The skipper of the steamer declines your fare on the up trip. You will come back later, you may pay then. If you raise your eyes from the landing they sweep up a long slope of birches a little striped by rock and snow falls from a niche in the cliff, then up a steep brown face of rock to a

platform at three thousand four hundred feet above the fiord steamer at the landing. If we take the camera and climb, in five hours we may stand above and see the whole valley spread out in bird's eye view. Under us the fiord, the terrace on which stand the scattered houses of Loen and the road beside the river to the lake, three miles away.

Both lake and fiord are of fresh water here, though the tide rises and falls four or five feet twice each day. No salt can be tasted in the fiord for many miles toward the sea. It is in such spots as this on each of the branches into which the fiord divides at its head that all the inhabitants of this part of the kingdom must live. The area here is small, the most distant wall being barely twelve miles away, but very hazy and blue with the water vapor in the air. If we walk along the road we find the scene park-like, with the mountain walls always towering far above the trees, while the far from silent river alongside puts a good deal of action into the scene, especially on the hot days, when the ice above melts freely. During much of this walk we have a summit in the background six thousand, six hundred feet above us, a Mount Washington with its feet at sea level. Presently we pass the last fall and come to the level of Loen Lake. A glance back shows us the cliff we have just ascended with its crest now above the clouds. Just before us is a tiny farm with all its lands. Over across the foot of the lake is a yet tinier one. This is known as a one place. When the son was grown he had to emigrate. All the farm lands are in sight. They are not cultivated by machinery. Part of the water that leaps so abundantly from above is utilized on one farm for a fulling mill, part of it for the farm grindstone, or tumbling wastefully over the grass when the sluice is closed.

There is a good deal of wood in the valley on all the lower slopes. From this the tips of the birches are cut when tender and dried to eke out the scanty store of winter hay. Farther back the Scotch spruce is still abundant. Houses here are of course of wood and though essentially log cabins they have been *tamed* by a thousand years of experiment into a curious affair of dressed and dovetailed timbers. It is made of planks four inches thick, and tongued each to the one above. There is no frame. The planks are dovetailed together at the corners, and partitions and floors are dovetailed through the solid sides. When the windows are sawed out, a slab is nailed across the space between them to hold the planks there together until they are supported by nailing to the window frame. Outside these planks goes an outer sheathing of inch-thick clapboards. When roofed with slate such a house gives an effect much like that of our frame

buildings. The mere log cabin only occurs on the mountain pastures where the cows pasture through the summer and the girls go up daily from the fiordside to care for the milk. These and the poorer houses are roofed with sod, often underlaid by birch bark to keep the rafters from rotting. The better buildings are everywhere roofed with red tile.

The brick and stucco houses of the cities are often of excellent design. Above the Loen Lake where ice and snow abound the slopes are full of the work of ice, wrecking and burrowing. This happens not merely at the summit of the cliff where the ice must fall over the edge, but at every point on the slope where it rests, there a great hole is dug. Little isolated glaciers that lie high up on the mountain side are always margined on the upper side by a cliff one or two hundred feet high as if showing how much the ice has recently sunk itself into the rock. Just below, if we are above the level where ice sometimes melts, lies the rough heap of moraine, big as the glacier itself and witness to its excavating power not only by the mass of rocky débris but also by the fresh unweathered gray color, while the cliffs all about are brown and purple.

Up beyond Loen Lake the valley is not unlike. The walls are steeper here, the scene is grander, for the upland surface is a mile above us and on it for three hundred and sixty square miles here rests the greatest glacier of Europe. There is little footing for continued human occupation, though. Near the lake head stood in 1904 two little settlements of Bodal and Naesdal, with sixty inhabitants between them. In the following winter almost every individual perished in a great wave from the lake, caused by the fall of an enormous mass of rock from the cliff above.

About the lake head the ground is too stony to cultivate. We may go up through the alders for two miles and emerge on a glacier bed which the ice abandoned only a few years ago. The trees end at the wall-like ridge of stones the ice had earlier pushed before it. Upon the valley floor we now perceive the river winding from side to side, strewing it all across with stony waste. Beyond, the glacier closes the valley, dull and dirty looking under the clouds, but glittering white when the sun bursts forth. We see then that there is little dirt upon it. Mostly it is white, clean ice resting on clean coarse gravel, with our river issuing from a blue cavern in the end.

If now in our search for places where man may dwell we climb five thousand feet above and look across the valley of the Loen Lake to the upland, the midsummer landscape of snow and ice shows little promise. From

the highest point in the region the prospect is even worse, a broad expanse of white picked out with rock. Such is west Norway seen from on top. Of such a land only the edges are usable. We saw some bits of habitation on the old sea bench beneath. At Froen it appears as a distinct bench on the landward side of one of the coast islands; dwellings and bench appear plainly. Outside on the ocean border where the cliffs are stripped bare by winter storms, a line of caves with a faint bench between marks the same ancient submergence of the land. It would hardly be possible to maintain life in a spot so exposed, but just within the entrance to the nearest fiord we find human dwellings in a place only better in its shelter from the ocean winds. They are not summer camps, but permanent homes. Farther up the fiord is a tiny farm that seems to me the completest type of human life in west Norway, though there may not be many like it.

A dike of softer rock has weathered back and formed a gully with soil on its floor. To right and left is only barren cliff of rock. At the water's edge the boathouse, the boat moored beside it; in the middle of the narrow stripe of grass the dwelling, and high above the shed that serves for barn; all three combine to show the Norseman making the most of every scanty patch of earth as he clings to the edge of a rocky land, ready always to fare out upon the waters. (See Fig. on p. 91.)

RECENT PUBLICATIONS

How the World is Clothed. Frank George Carpenter. Pp. 335. New York, The American Book Company, 1908.

Carpenter's How The World Is Clothed is a companion volume to his earlier volume on How The World Is Fed, and treats of the chief products used for clothing and ornamentation, in an inclusive and helpful way. The whole field is covered from the cotton plant to needles and pins. Each topic is treated with care so as to show the area of production, the stages of manufacture and the relative importance of the products. The book is fairly well illustrated and is in most ways satisfactory. The chief defect is that it is written according to the "imaginary journey" idea, a plan which is very useful for children of certain ages. The plan as followed here, however, seems somewhat artificial and unnecessary and would not appeal to children of the upper grades. As a whole the book is one of the most successful of the author's several supplementary readers.

In Viking Land. Norway, Its People, Its Fjords and Its Fyelds. By Will S. Monroe; pp. xxiv+332. Boston, L. C. Page & Company, 1908.

The well-known teacher and educational writer who is the author of In Viking Land has given us a very attractive, readable volume concerning a country in which every one is interested. The book is very interesting in scope, appealing in style, well thought out, finely printed and splendidly illustrated. The twenty chapters into which the book is divided deal with the history of the Kingdom, its geography, its people, its industries, the striking scenic centers, the chief cities and the music, art and literature of the country. Every chapter is well written and the story as a whole is satisfying and interesting. A splendid book for the general reader and as a collateral volume in the upper grammar grades.